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APPLICATION FOR UNITED STATES LETTERS PATENT

FOR

CELLULOSIC/POLYMER COMPOSITE MATERIAL

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CELLULOSIC/POLYMER COMPOSITE MATERIAL

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This Application claims the benefit of U.S. Provisional Application No. 60/135,443, filed May 22, 1999.

BACKGROUND AND SUMMARY OF THE INVENTION

The present invention relates generally to wood replacement materials, and more particularly, to cellulosic/polymer composite materials. The present invention will be described primarily with reference to wood flour/polyvinyl chloride (PVC) composites and wood flour/polypropylene composites. However, the present invention includes several different formulations and material composites including, but not limited to, PVC formulations and polypropylene formulations that include an inorganic filler in addition to the cellulosic material.

The supply of natural woods for construction and other purposes is dwindling. As a result, many are concerned about conserving the world's forests, and the cost of natural woods has risen. In light of these factors, a tremendous demand has developed in recent years for cellulosic/polymer composites that exhibit the look and feel of natural woods.

Cellulosic/polymer composites are used as replacements for all-natural wood, particle board, wafer board, and other similar materials. For example, U.S. Patent Nos. 3,908,902, 4,091,153, 4,686,251, 4,708,623, 5,002,713, 5,055,247, 5,087,400, and 5,151,238 relate to processes for making wood replacement products. As compared to natural woods, cellulosic/polymer composites offer superior resistance to wear and tear. In particular, cellulosic/polymer composites have enhanced resistance to moisture. In fact, it is well known that the retention of moisture is a primary cause of the warping, splintering, and discoloration of

natural woods. Moreover, cellulosic/polymer composites may be sawed, sanded, shaped, turned, fastened, and finished in the same manner as natural woods. Therefore, cellulosic/polymer composites are commonly used for applications such as interior and exterior decorative house moldings, picture frames, furniture, porch decks, deck railings, window moldings, window components, door components, roofing structures, building siding, and other suitable indoor and outdoor items.

The present invention provides cellulosic/polymer composite materials that can be produced in a commercially reasonable environment. One example of the present invention is a cellulosic/PVC composite, and another example of the present invention is a cellulosic/polypropylene composite. The cellulosic/polymer compositions of the present invention can be processed and shaped into resultant products having desired appearance, strength, durability, and weatherability. In addition, the present invention provides improved methods of making such cellulosic/polymer composites.

In addition to the novel features and advantages mentioned above, other objects and advantages of the present invention will be readily apparent from the following descriptions of the drawings and preferred embodiments.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a side elevation view of a siding unit made with a cellulosic/polymer composite of the present invention;

Figure 2 is an exterior plan view of the siding unit of Figure 1;

Figure 3 is an interior plan view of the siding unit of Figure 1; and

Figure 4 is a side elevation view of another siding unit made with a cellulosic/polymer composite of the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENT(S)

The present invention is directed to cellulosic/polymer composite materials. The present invention also includes methods of manufacturing cellulosic/polymer composite materials. The cellulosic/polymer composite materials of the present invention can be used as a substitute for natural wood, particle board, wafer board, and other similar materials. For example, the composites of the present invention can be used to make interior and exterior decorative house moldings, picture frames, furniture, porch decks, deck railings, window moldings, window components, door components, roofing structures, building siding, and other suitable indoor and outdoor items.

Figures **1** through **3** show an example of a siding unit **10** that can be made with a composite of the present invention. Figure **4** shows another example of a siding unit **20** that can be made with a composite of the present invention. It shall be understood that the siding units may be comprised of any desired number of rows or courses. As shown in Figures **1** through **4**, at least one backer **12, 22** may optionally be secured to the inside of at least one respective facing panel **14, 24**. A backer may be comprised of a sufficiently rigid, insulating material such as expanded or extruded polystyrene foam, fiberglass, cardboard, a fire retardant grade of polyurethane foam, or any other suitable, conventional, or similar material.

The materials that may be used to make the composites of the present invention include, but are not limited to, cellulosic fillers, polymers, inorganic fillers, cross-linking agents, lubricants, process aids, stabilizers, accelerators, inhibitors, enhancers, compatibilizers, blowing

agents, foaming agents, thermosetting materials, and other suitable materials. Examples of cellulosic fillers include sawdust, newspapers, alfalfa, wheat pulp, wood chips, wood fibers, wood particles, ground wood, wood flour, wood flakes, wood veneers, wood laminates, paper, cardboard, straw, cotton, rice hulls, coconut shells, peanut shells, bagass, plant fibers, bamboo fiber, palm fiber, kenaf, and other similar materials. Examples of polymers include multilayer films, high density polyethylene (HDPE), polypropylene, PVC, low density polyethylene (LDPE), chlorinated polyvinyl chloride (CPVC), acrylonitrile butadiene styrene (ABS), ethyl-vinyl acetate, other similar copolymers, other similar, suitable, or conventional thermoplastic materials, and formulations that incorporate any of the aforementioned polymers. Examples of inorganic fillers include talc, calcium carbonate, kaolin clay, magnesium oxide, titanium dioxide, silica, mica, barium sulfate, and other similar, suitable, or conventional materials. Examples of cross-linking agents include polyurethanes, such as isocyanates, phenolic resins, unsaturated polyesters, epoxy resins, and other similar, suitable, or conventional materials. Combinations of the aforementioned materials are also examples of cross-linking agents. Examples of lubricants include zinc stearate, calcium stearate, esters, amide wax, paraffin wax, ethylene bis-stearamide, and other similar, suitable, or conventional materials. Examples of stabilizers include tin stabilizers, lead and metal soaps such as barium, cadmium, and zinc, and other similar, suitable, or conventional materials. In addition, examples of process aids include acrylic modifiers and other similar, suitable, or conventional materials.

One embodiment of the present invention is a cellulosic/PVC composite material. The composite material may include at least one cellulosic filler in the amount of about 30% to about 60% by weight, more preferably about 40% to about 50% by weight, and still more preferably

about 48% to about 50% by weight. The composite may also include a PVC material in the amount of about 40% to about 70% by weight, more preferably about 50% to about 60% by weight, and still more preferably about 50% to about 52% by weight.

The cellulosic filler(s) may be dried to a desired moisture content. For example, the cellulosic filler(s) may be dried to about 0.5% to about 3% moisture content by weight, more preferably to about 1% to about 2% moisture content by weight. However, it is appreciated that the cellulosic filler(s) may have a moisture content less than about 0.5% by weight or greater than about 3% by weight.

The PVC material can be made by mixing a PVC resin, at least one stabilizer, at least one lubricant, at least one process aid, and optional other ingredients in a mixer. An example of a mixer is a high intensity mixer such as those made by Littleford Day Inc. or Henschel Mixers America Inc. As an example, the mechanically induced friction may heat the ingredients to a temperature between about 200° F and about 230° F. After mixing, the ingredients may be cooled to ambient temperature.

The PVC material may include stabilizer(s) in an amount of about 1 to about 10 parts, more preferably about 3 to about 5 parts, per 100 parts of the PVC resin. The lubricant(s) may be present in an amount of about 2 to about 12 parts, more preferably about 4 to about 8 parts, per 100 parts of the PVC resin. Also, process aid(s) may be included in an amount of about 0.5 to about 8 parts, more preferably about 1 to about 3 parts, per 100 parts of the PVC resin. Optionally, at least one inorganic filler may be added in an amount of up to about 10 parts, more preferably up to about 5 parts, per 100 parts of the PVC resin.

The PVC resin may have any desired inherent viscosity. The inherent viscosity is preferably between about 0.6 and 1.1 and more preferably between about 0.7 and 0.9. Nevertheless, it is appreciated that the inherent viscosity of the PVC resin may be less than 0.6 or greater than 1.1.

The cellulosic filler(s) and the PVC material may be mixed together prior to being further processed such as by extrusion or molding. For example, a low intensity mixer may be used to mix the cellulosic filler(s) and the PVC material. An example of a low intensity mixer is a ribbon blender.

The composite material may be processed in an extruder, a compression molding apparatus, or any other suitable, similar, or conventional apparatus. An example of an extruder is a conical, twin screw, counter-rotating extruder with a vent. A force feed hopper or crammer or any other suitable, similar, or conventional apparatus may be used to feed the materials into the extruder. The composite material may be extruded through a die system. The die system may have a compaction ratio between about 2:1 and 4:1. The die system may include an extended die land to provide sufficient back pressure for a uniform melt as well as compaction and shaping of the melt.

Another example of the present invention is a cellulosic/polypropylene composite material. The composite material may be comprised of at least one cellulosic filler in an amount of about 30% to about 70% by weight, more preferably about 40% to about 50% by weight. Additionally, the composite material may be comprised of a polypropylene material in an amount of about 30% to about 70% by weight, more preferably about 50% to about 60% by weight.

The cellulosic filler(s) may be dried to a desired moisture content. For example, the cellulosic filler(s) may be dried to about 0.5% to about 3% moisture content by weight, more preferably to about 1% to about 2% moisture content by weight. However, it is appreciated that the cellulosic filler(s) may have a moisture content less than about 0.5% by weight or greater than about 3% by weight.

The polypropylene material includes at least one lubricant in an amount of about 10 to about 20 parts per 100 parts of a polypropylene resin. More preferably, the polypropylene material includes at least one lubricant in an amount of about 14 to about 19 parts per 100 parts of the polypropylene resin. The polypropylene material may also include at least one inorganic filler in an amount up to about 70 parts, more preferably between about 20 and 60 parts, per 100 parts of the polypropylene resin.

Optionally, the polypropylene material may be mixed together in a mixer such as any of those described above. After the cellulosic filler(s) are dried to a desired level, the cellulosic filler(s) and the polypropylene material may be mixed together using a mixer such as the above-described low or high intensity mixers. The composite material may then be processed by extrusion, compression molding, or any other similar, suitable, or conventional processing technique. The extrusion system may include any of the optional or preferred features of the above-described embodiment of the present invention.

EXAMPLES

A cellulosic/PVC composite was made which comprised about 111 parts of a cellulosic filler and about 112 parts of a PVC material. The PVC material was comprised of about 100 parts of a PVC resin, about 4 parts stabilizer, about 6 parts lubricants, and about 2 parts process aids. The cellulosic filler and the PVC material were mixed together and extruded. The resultant product exhibited desired appearance, strength, durability, and weatherability.

A cellulosic/polypropylene composite was also made which comprised about 143 parts of a cellulosic filler and about 136 parts of a polypropylene material. The polypropylene material was comprised of about 100 parts polypropylene resin, about 15 parts lubricants, and about 21 parts of an inorganic filler. The composite was made by first drying the wood flour to about 2% or less moisture content. The polypropylene resin, lubricants, and inorganic filler were then added and blended for about 5 minutes. Next, the composite material was extruded to form an article having desired appearance, strength, durability, and weatherability.

The preferred embodiments herein disclosed are not intended to be exhaustive or to unnecessarily limit the scope of the invention. The preferred embodiments were chosen and described in order to explain the principles of the present invention so that others skilled in the art may practice the invention. Having shown and described preferred embodiments of the present invention, those skilled in the art will realize that many variations and modifications may be made to affect the described invention. Many of those variations and modifications will provide the same result and fall within the spirit of the invention. It is the intention, therefore, to limit the invention only as indicated by the scope of the claims.